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Gazella gazella.

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Gazella gazella (Pallas, 1766)

Mountain Gazelle

Antilope gazella Pallas, 1766:7. Type locality "Syria".
Antilope cora Smith, 1827:216. Type locality "Persian Gulf".
Gazella muscatensis Brooke, 1874:142. Type locality "Muscat" [Oman].
Gazella merrilli Thomas, 1904:347. Type locality "Hizmeh, north of Jerusalem".

CONTEXT AND CONTENT. This is one of several closely related species in the central group of the genus *Gazella*; others include *G. dorcas*, *G. saudiya*, *G. arabica* and *G. bilkis*, all found in the Middle East (and, in the case of *G. dorcas*, in the Sahara as well–Groves, 1985).

Subspecies recognized by Groves and Harrison (1967) are:

G. g. cora Smith, 1827:216, see above (*erlangeri* Newman, *typica* Ward, and *hanishi* Dollman are synonyms).
G. g. farasani (Thouless and Al Bassri, 1991:154). Type locality "northern Farasan Kebir, Farasan Islands, Saudi Arabia".
G. g. gazella Pallas, 1766:7, see above *merrilli* Thomas is a synonym.
G. g. muscatensis Brooke, 1874:142, see above.

DIAGNOSIS. Compared with *G. dorcas*, *G. gazella* (Fig. 1) averages larger (mass of adult male 17–29.5 kg; of adult female 16.5–25 kg, compared with 15–18.2 kg and 11.4–14.5 kg, respectively, in *G. dorcas*); ears generally less than 130 mm, 10.2–13.5% of head and body length (at least 14% in *G. dorcas*); the hindlegs are longer, the intermembral index (forelimb length as percent of hindlimb length) is 77.1–79.6 (79.0–83.6 in *G. dorcas*); distal limb segments are shorter, tibia length is less than 130% of femur length (>130% in *G. dorcas*), and metatarsal length is less than 106% of femur length (more than this in *G. dorcas*, authors' unpublished data).

The horn cores are elliptical in cross-section (round in *G. dorcas*—Tchernov et al., 1986/7); there is a broad groove running up the anterior aspect of the core, with a less marked one medial to it, and another groove runs up the posterior border (Davis, 1980; Ducos, 1968; Tchernov et al., 1986/7). *G. dorcas* has no groove in the anterior edge, but the posterior edge is grooved (Tchernov et al., 1986/7). The horns of adult males are of medium length (220–294 mm) compared with the horns (250–280 mm) of *G. dorcas*, set wide apart at their bases with a gap of about 25 mm between them, always somewhat bowed outwards with the tips turned inward, and the span across the widest spread is 104–170 mm. The horns of adult females are short (84–153 mm) and nearly smooth, whereas those of *G. dorcas* females vary greatly in size, and have inwardly turned tips, and a wider basal gap (Mendelssohn and Yom-Tov, 1987).

In *G. gazella*, the nasal bones scarcely overlap the posterior extremities of the premaxillae, and are usually greatest in width proximally; they do not penetrate deeply between the frontals posteriorly (Fig. 2). The coronal suture of the skull usually is doubly bowed. In *G. dorcas* the nasal bones overlap the posterior extremities of the premaxillae, are usually broad distally, and penetrate deeply between the frontals posteriorly (Harrison and Bates, 1991).

Few quantitative data exist for the other two sympatric gazelle species, both of which are rare and threatened with extinction. The following diagnostic characters are typical: In *G. bilkis*, the horns of adult males are of medium length (204–254 mm), upright and nearly straight, not bowed outwards, and the tips not turned inward, with scarcely any sigmoid curvature in side-view; the span across the widest spread is only 86–102 mm. The horns of adult females are well developed (137–151 mm), well ringed, and curve slightly backward. Pelage color is exceptionally dark, with the dorsum, forehead, and top of the muzzle nearly black; the rather light flanks contrast with the broad black flank stripes, each having a reddish line below separating it from the white underparts (Harrison and Bates, 1991).

In *G. subgutturosa*, the horns of adult males are long (203–312 mm), usually widely divergent at the tips and lyrate, close together at their bases, with a gap usually less than 15 mm. Adult females usually are hornless, or with variably developed horns, occasionally attaining 220 mm in length. The male has a goiter-like throat swelling in the breeding season. Their mass averages larger than that of *G. gazella*. Pelage color is variable, with the face usually whitish; facial, flank, and pygal stripes usually are ill-defined. Individual variation in color, horn formation, and cranial characters in

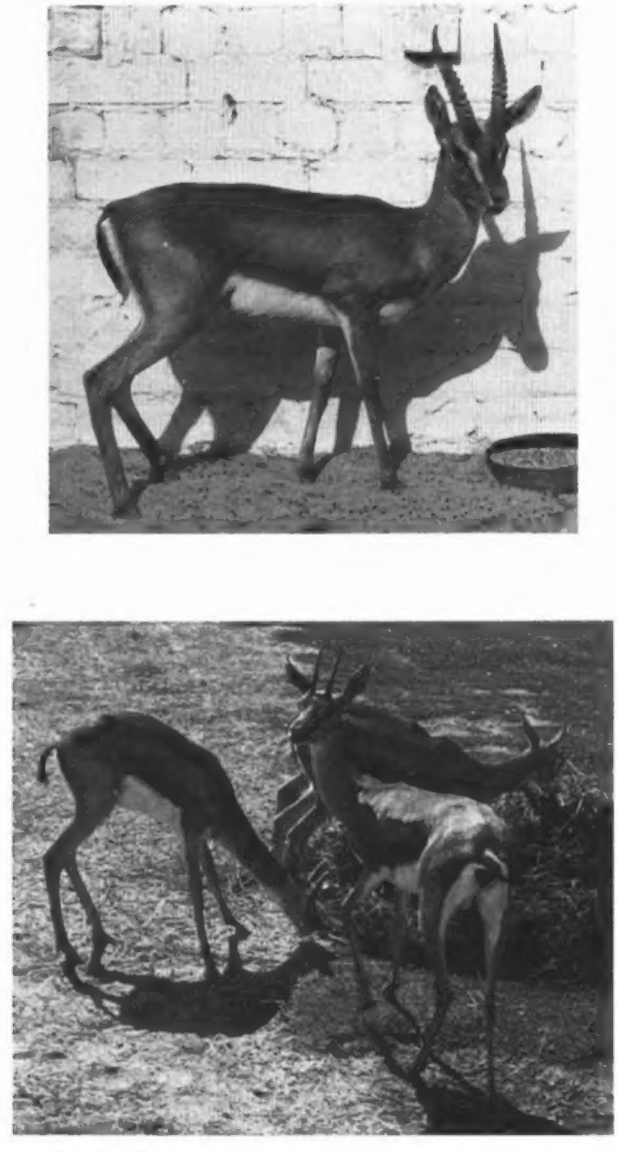

FIG. 1. Photographs of a male (above) and a female (below) of *Gazella gazella* from Israel. Photograph by A. Shoob.

FIG. 2. Left, dorsal, ventral, and lateral views of the cranium, and lateral view of the mandible of a male *Gazella gazella* from Hamadiya, Israel (Zoological Museum, Tel Aviv University, M. 4707); greatest length of skull is 194.4 mm. Right, same views for a female from Gesher, Israel (Zoological Museum, Tel Aviv University, M. 5242); greatest length of skull is 181.1 mm. Photographs by A. Shoob.

the genus *Gazella*, however, is so great as to make any simple key to identification virtually impossible (Harrison and Bates, 1991).

GENERAL CHARACTERS. *G. gazella* is sexually dimorphic, with males larger than females, and possessing longer horns. In the largest subspecies, *G. g. gazella*, mean and ranges of measurements (in mm) for males and females, respectively, are: length of horn, 248 (220–291) and 82 (58–115); length of head and body, 1053 (1010–1150) and 980 (910–1010); length of tail, 105 (80–130) and 105 (90–130); length of hindfoot, 336 (320–354) and 322 (320–340); length of ear, 119 (112–123) and 116 (110–125); greatest length of skull, 192.2 (186–196.1) and 179.8 (172–186.2); body mass (kg), 24.86 (17.1–29.5) and 18.09 (16.25–25.0—Mendelssohn and Yom-Tov, 1987). Desert subspecies are smaller: length of head and body of a male of the undescribed Negev form was 1000 mm and mass only 16 kg, but length of tail was 155 mm, and length of ear was 135 mm (authors' unpublished measurements); length of head and body of a male of *G. g. cora* from Saudia Arabia was 1041 mm, and a male *G. g. muscatensis* from Oman, only 992 mm. Skull measurements of the desert races are also less (Groves, 1969; Groves and Harrison, 1967).

The horns of males are rather short and thick, with prominent rings. The horns of females are generally less than 70% the length of the male's horns in the same population. The female horns are unringed and rather irregular in shape, in contrast to females of all other members of the species-group as defined above, as far as known (Groves, 1969; Groves and Lay, 1985). The facial stripes are off-white, and have dark brown or black lower margins; the midfacial stripe is medium to dark brown, usually with a blackish nose spot. There is a strong contrast between the dark (sandy-brown to gray-brown) tone of the dorsum, flanks and upper part of the haunches, and the lighter brown of the limbs. A dark brown or black flank-band separates the dark-toned dorsal color from the white underparts; a lighter, fawn-colored streak is located above it. In the skull the fronto-nasal suture is in the form of a U, the nasals are wider posteriorly than anteriorly, and the lateral anterior flanges are

shorter than the median tips; the premaxilla is short, its palatal portion straight and no longer than the predental portion of the maxilla, its ascending process often not reaching the nasal bones; the paroccipital processes turn posteriorly near their tips; the parietal ridges are marked; the fronto-parietal suture curves backward behind each horn; and there is a deep preorbital fossa (Groves, 1969; Groves and Lay, 1985). The toothrows are nearly straight; the combined length of the premolars forms 37.5–41% of the toothrow length; the lingual styles and valleys on the cheekteeth are angular; the talonid on M_3 is short (Groves and Lay, 1985).

Gazella g. gazella and *G. g. muscatensis* are darker arid zone subspecies, but the former has rather straight horns (slightly S-shaped in side view), whereas *G. g. muscatensis* has very outbowed horns with inturned tips. The skull varies geographically in whether the premaxilla reaches the nasals: it usually does (but with a point contact only) in *G. g. cora* from Saudi Arabia, rarely in *G. g. muscatensis*, and never in *G. g. gazella* (Harrison, 1968).

DISTRIBUTION. *G. gazella* occurred in southern Lebanon, Syria, Israel, west and south of the Arabian Peninsula, and isolated regions in Iran. Due to overhunting there is now a hiatus in its distribution in the northern Negev in Israel; it probably extends into southern Lebanon (Fig. 3). Reports of its occurrence in the Sinai Desert probably are in error; the only gazelle found there today is *G. dorcas* (Ferguson, 1981). In Saudi Arabia, it is found along the Red Sea coast (Tihama) and in the Asir Mountains, and a little farther inland (Nader, 1989; Thouless et al., 1991); it occurs along the coasts and in the mountains of Yemen and Oman (Harrison, 1968), and in the United Arab Emirates (Gross, 1987). A population was identified recently on Forur Island, Iran (in the Persian Gulf), where it had been introduced from the Kavir National Park, southeast of Teheran (M. Karami, pers. comm.). Its distribution thus extends much farther northward than hitherto known. It is common on Forur Island (Iran), on the Farasan Islands, and in Oman; elsewhere it is in danger of extinction (Thouless et al., 1991).

Two populations of the mountain gazelle occur in Israel. *G. g. gazella* occurs north and west of the 150 mm isohyte, and a small population of an undescribed subspecies is found in the Arava Rift Valley in the Negev, 50 km north of Elat. In recent years *G. gazella* has appeared in the Judean desert, and has penetrated to the coastal plain of the Dead Sea, following irrigated agriculture in these areas (Mendelssohn and Yom-Tov, 1987).

FOSSIL RECORD. Fossils ascribed to *Gazella sensu lato* are known from the middle Miocene, but *G. gazella* itself is not known from earlier than the Upper Pleistocene. Taxa from the sites of Tabun, El Wad, Hayonim and Kebara, described by Bate (1940) under the names *Gazella decora*, *G. estraelonia*, *G. arista* and *Kobus cananites*, represent the extant species (Davis, 1980). Presumed early Holocene occurrences are from Kara'in Cave, Turkey; central Lebanon; Petra, Jordan; and Hesban, Jordan, east of Jericho, West Bank areas (where what has been described as *G. gazella* occurred with *G. dorcas* (Uerpmann, 1986)).

G. gazella was the only gazelle species documented in Israel until after the Pre-Pottery Neolithic B. periods (Tchernov et al., 1986/7). In the last glacial period its range expanded southward, reaching the southern Sinai Peninsula. The desert subspecies of *G. gazella* in the southern Arava Valley may be a glacial isolate.

FORM. The nominate subspecies is, compared with most other gazelles, more stockily built, a character that may be adaptive to life in mountainous habitats. The length of head and body averages 1050 mm (1000–1140, $n = 9$) in males, and 980 mm (920–1040, $n = 4$) in females. The average length of the relatively short, black tail is 100 mm, but there is considerable variability in length and bushiness. The ears are relatively short, about 120 mm, and generally are carried in an upright position in *G. g. gazella*, but longer (120–140 mm), and carried obliquely outward, in desert subspecies. The length of the hindfoot is 340 mm in males, and 320 mm in females. The average mass in specimens from Israel is 25 kg (22.5–28, $n = 9$) in males, and 18 kg (16.2–25.0, $n = 10$) in females, but large males may reach 29.5 kg. The largest gazelles in Israel, and those with the longest horns, are found in Upper Galilee, but large specimens occur elsewhere. Gazelles do not accumulate considerable fat reserves even under the most favorable conditions or in captivity. Desert subspecies are much lighter and longer-legged; a male from the Negev has a mass of 16 kg although its linear measurements were about the same as specimens occurring in northern Israel

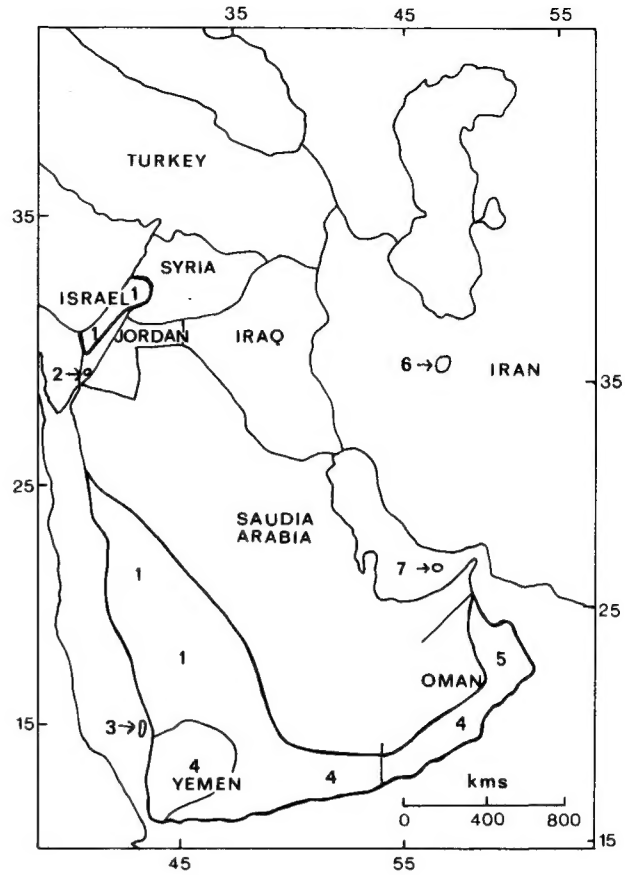

FIG. 3. Geographic distribution of *Gazella gazella*, adapted with modifications from Harrison and Bates (1991). 1, *G. g. gazella*; 2, isolated population of undescribed subspecies; 3, *G. g. farasani*; 4, *G. g. cora*; 5, *G. g. muscatensis*; 6, undescribed subspecies in Kavir National Park, Iran; 7, introduced to Forur Island from Kavir National Park, Iran.

(authors' data). The mass of specimens from the United Arab Emirates was 12 kg (Gross, 1987).

The horns of males are 220–294 mm long, thick basally, and have 14 to 20 rings. When viewed from the side they are more or less sigmoid, with the tips turned forward. When viewed from the front, the horns are more or less divergent, from almost parallel to widely divergent at an angle of ca. 30°. Horns in most subspecies may be quite straight or have a slight lyrate form, but are more strongly outbowed in Persian Gulf subspecies. Variation in horn shape may be great within populations. Mountain gazelles in southern Israel generally have smaller horns than do those in the north and in Arabia, and those of the Persian Gulf region are shortest. Female horns are much smaller and thinner and generally without rings; their length is about 100–120 mm, and female horns longer than 150 mm are rare. Female horns are often bent, crooked, or broken, but are still used for butting small predators threatening their offspring, or for butting other females. In males, the horns form an angle of 60° to the basifacial axis; in females, about 30° (C. Groves, pers. obs.).

The short premaxillae do not contact the nasals. The skull has deep supraorbital pits, with large foramina within them. The vertebral formula is C 7, T 12–13, L 6–7, S 5, Cd ca. 14, total 44–46 (C. Groves, pers. obs.).

The pelage is short, sleek and glossy in summer, reflecting much of the sun radiation. In winter the pelage is much longer, denser, rainproof, and not glossy, enabling the gazelles to withstand the heavy winter rains (800–1000 mm) in Upper Galilee in their open habitats without need for protection; seasonal variation in pelage characteristics is much less in desert subspecies. In winter the hairs are especially long on the breast and abdomen, insulating the body from the cold and wet soil when the gazelles bed down (Mendelssohn, 1974).

The color of the dorsal pelage is earth-brown, but is lighter in drier regions. A dark brown side stripe commonly separates the brown upper side and the white underside, and a lighter brown stripe runs above this along the flanks. The legs are lighter than the body, and often there is a sharp transition between the dark body and light leg tones on the rump. The hairs on the rump are long and white, surrounded by a dark brown line (Mendelssohn and Yom-Tov, 1987).

G. gazella have poorly developed preorbital glands and, apparently, not used in some subspecies (but they are used for marking in *G. g. cora*—Gross, 1987). Glands at the carpal joints are associated with brushes of long, stiff hairs. Well-developed interdigital and inguinal glands may leave odorous traces on the ground vegetation (Mendelssohn and Yom-Tov, 1987).

The gall bladder is small, lying in a fossa in the liver; the caudate lobe is small and lateral in position; a Spigelian lobe is present, unlike in *G. dorcas*, and is oviform. The papillae in the rumen are short and flattened; the cells of the reticulum of a "fair depth"; and the laminae of the psalterium are triplicate in disposition. The glans penis is enlarged and resembles that of a sheep (*Ovis aries*), and the urethra is free for ca. 25 mm (Garrod, 1877).

FUNCTION. Mountain gazelles can withstand severe climatic conditions. They live in the hot and dry Jordan Valley, the Negev Desert, and the Nafud and Dhofar Deserts, where mid-day summer temperatures often approach 45°C, and in the Upper Galilee where sub-zero (Celsius) temperatures are not rare on winter nights, and snow sometimes covers the ground for several days. They appear to be best adapted to an average annual temperature of 21°–23°C, average winter temperature of not lower than 14°C, and annual precipitation of 300–400 mm. During rainy periods they may seek refuge in places protected from wind, but usually they are exposed to rain. The effects of tranquilizer on heart rate and hematological values were reported by Furley (1986).

ONTOGENY AND REPRODUCTION. Under natural conditions mating takes place during autumn (October–November), but near agricultural areas, where green food and water are available throughout the year, mating takes place year round. Such is the case in northern and central Israel and on the southern Golan Heights where young are born year round, peaking in spring (April–June). In Oman, on the Batinah coast, gazelles of this species breed twice a year, in January and July–August; females, therefore, may be accompanied by a newborn and a six-month old fawn (Harrison, 1968). In the Farasan Islands, this species breeds throughout the year (Habibi, 1992*a*).

Males follow female herds passing or grazing in the male's territory. A male follows an estrous female and performs the foreleg-kick (Walther, 1958). While following an estrous female, the male smells her genital area, and performs "Flehmen" when she urinates; he then mounts her repeatedly several times per minute (Habibi, 1992*b*) until copulation is achieved. Copulation lasts only seconds, and is usually performed while walking. During copulation the male bends his front legs, and during ejaculation is in an almost upright position, pushing the female forward (Sambraus, 1973).

Estrus occurs on average every 18 days (16–40 days) in captivity, and normally lasts 12–24 hours, occasionally 36 hours (Mendelssohn, pers. obs.). During estrus a female copulates several times, and in nature females were observed copulating with more than one male. If the female does not conceive she may become estrous several times in succession until fertilization occurs. Gestation lasts 180 days (±5). Before parturition the pregnant female leaves the herd and delivers in isolation. Mass of the newborn is about 1.75–2.5 kg, 11–12% of its mother's mass (Mendelssohn and Yom-Tov, 1987). Neonate males are about 5% heavier than females (H. Mendelssohn, unpublished data).

The newborn is well developed, having open eyes and fully developed pelage. Immediately after birth the female licks the young and eats the afterbirth tissues. The newborn tries to stand within the first hour after birth, and stands on the full length of the toes rather than on the tips.

Normally the first fawn is born when the dam is 2 years old, but near agricultural areas many females which are one-year old give birth (Mendelssohn, 1974). In such areas, and in captivity, nursing females may become estrous and pregnant, thus producing two fawns in one year. Only one instance of twins is known in Israel (Mendelssohn and Yom-Tov, 1987).

Nursing is carried out standing in an anti-parallel posture: the young suckles while the female licks the umbilical and genital region of the young. This enhances defecation and urination by the young, and the mother eats its feces. Suckling lasts minutes (or less than a minute) and takes place several times a day. During the first weeks of its life the young spends most of the day lying curled up with eyes closed in a shallow depression in the soil, under bushes, or in high vegetation. The dam grazes or rests up to ca. 100 m from the hidden fawn, but guards it, attacking small potential predators (i.e., red fox, *Vulpes vulpes*), or trying to lead larger predators (i.e., jackal, *Canis aureus*) away from it. A strong defense reaction is released by the alarm bleating of the fawn. After nursing she observes the fawn seeking a hide and remembers this hide exactly (Mendelssohn, 1974).

In the first few days after birth, fawns approach any adult, but the mother's extensive licking probably acts to establish the mother-young bond. At ca. 3–6 weeks of age the young gradually begins to accompany its mother and starts feeding on solid food. The suckling period lasts up to 3 months. At about that age the mother and young join a small female and young herd of 4–16 individuals. Females remain with their mother's herd perhaps for life, but males leave the maternal herd when about 6 months old and join herds of young males (Mendelssohn and Yom-Tov, 1987).

At birth the fawn has three premolars and one molar on each side of both jaws. Two molars erupt by 2 months, three molars by 6 months and all are fully developed by 12 months. At 18 months, milk teeth start to be replaced, a process completed by 24 months. Dental attrition varies and depends greatly on diet (Mendelssohn and Yom-Tov, 1987).

Females reach adult mass at 18 months, males at 3 years. Under favorable food conditions (in captivity and in agricultural areas) females may conceive at 5–7 months and males may impregnate at 15–20 months. Under natural conditions, however, females first conceive at 18 months and males are able to occupy territories when they are 3 years old. Life expectancy is 13 years in captivity, but rarely more than 8 years in nature. In several cases, captive females gave birth up to the age of 13 years, but most could not withstand the stress of pregnancy and lactation; their condition deteriorated after parturition and they died (Mendelssohn and Yom-Tov, 1987).

ECOLOGY. The mountain gazelle lives in many habitats, but not in dense forest or chaparral. It often lives in very steep (up to 45°) terrain, but avoids rocky areas or walking on rocks. Gazelles attempt to walk on well-worn trails that follow the contour of slopes. When climbing a slope they walk on oblique trails, but when frightened they may run straight up the slope. They may jump down from meter-high rock walls but they jump upward only when they can see their landing place (Mendelssohn and Yom-Tov, 1987).

The distribution of this species in the Arabian peninsula (Vesey-Fitzgerald, 1952), and in the southern Negev (Mendelssohn et al., in prep), coincides closely with that of *Acacia*. It extends from valleys to foothills and open rock or sand plains, and to the borders of the true sand areas (Morrison-Scott, 1939). In Arabia, it usually lives on rough terrain of montane wadi beds, gorges, and rolling hills (Habibi, 1992*b*).

In Israel and Saudi Arabia most natural predators of gazelles (the cheetah *Acinonyx jubatus*, the leopard *Panthera pardus* and the wolf *Canis lupus*) either were exterminated (cheetah) or drastically reduced in number (wolf and leopard). Rarely is an adult gazelle in danger from predators, but caracals (*Lynx caracal*), wolves, and packs of feral dogs, are known to hunt adult gazelles with the caracal appearing to be the most efficient. Fawns might be taken by red foxes (*Vulpes vulpes*), jackals (*Canis aureus*), and hyaenas (*Hyaena hyaena*) and feral dogs. Although the first two of these predators are common in areas inhabited by *G. g. gazella*, they do not significantly affect gazelle populations (Mendelssohn and Yom-Tov, 1987).

In northern Israel during winter gazelles feed mainly on grasses, and later on spring dicotyledons. During summer when green food is scarce, they browse on the leaves of *Ziziphus lotus*, a common low shrub; during autumn before the rains, they feed on *Cynodon dactylon*, a common weed, and on acorns of oaks (*Quercus*) when available. Only a few plants are rejected altogether, and even plants that are known to be poisonous and not accepted by most herbivores, such as various Solanaceae, Oleander (*Nerium oleander*), *Urginia maritima* and leaves of the fig tree (*Ficus carica*), are eaten. The small population of mountain gazelle in the southern Arava valley (*G. gazella* subsp.) feeds mainly on leaves and pods of *Acacia* trees,

commonly reached by standing on the hind legs and leaning on the branches with the front legs, not unlike the gerenuk (*Litocranius walleri*). Possibly as an adaptation to this browsing behavior, *G. gazella* subsp. have relatively longer necks and legs than does *G. g. gazella*. This population feeds also on leaves and young twigs of several shrubs (*Lycium arabicum, Nitraria retusa, Ochradenus bacatus* and *Loranthus acaceae*) (Shalmon, 1988, and pers. comm.).

Gazelles of this species were seen feeding in cultivated fields at different altitudes on the road from Hodeida to Ma'abar, Yemen (Sanborn and Hoogstraal, 1953). On the Farasan Islands, gazelles browse on *Cyperus*, mainly at night (Flamand et al., 1988).

Feeding occurs mainly during the day but also during moonlit nights. When persecuted by humans much of their activity, feeding included, occurs at night. During the hot, dry summer much of the feeding (and other activities) is carried out in early morning and late afternoon and evening when temperatures are lower and water content of their dry food is higher. In the high altitude barren plain near Ma'abar, Yemen, gazelles of this species (misreported as *Gazella dorcas saudiya*) were seen only by day, never by night, whereas in the lowlands near Hodeida they were seen at dusk and at night (Sanborn and Hoogstraal, 1953).

G. gazella prefers to drink water daily during summer, but do not always do so. Some populations exist in areas where no sources of surface water are known. In such areas gazelles improve their water balance by digging with their front legs for bulbs, corms, and other succulent subterranean plant organs, or even by travelling to distant water sources. When dehydrated a gazelle may drink up to 2.5 liters of water within minutes. Meinertzhagen (1954) reported this species in Saudi Arabia drinking sea water, but this observation is questionable because gazelles are not known to feed on salt plants (H. Mendelssohn, pers. obs.).

In a nature reserve in Israel, gazelles were found to harbor the fluke *Fasciola gigantica* (Nobel et al., 1972). In Tel Aviv zoo, cases of toxoplasmosis and of the esophageal nematode *Gongylonema pulchrum* were recorded (Neumann and Nobel, 1978; Nobel et al., 1969).

At low population densities of less than 15 per km² in northern Israel, gazelles are remarkably free of diseases or parasites. At densities of 30–40 individuals per km², however, infestation by ticks and worms (mainly lung worms) was noted (D. Barahav, pers. comm.).

An outbreak of foot and mouth disease, caused by virus type O, occurred in gazelle populations in northern Israel in the spring of 1985 (Shimshony et al., 1986). It reached extensive proportions with an estimated mortality of 50% (1500 animals) in the Ramot Yissakhar Game Reserve; many other individuals suffered from various symptoms, including severe oral lesions, macroscopically visible muscular lesions in the heart, peeling of the hoofs and horns, typical buccal symptoms, and coronary and interdigital vesicles, but no diarrhea. The outbreak subsided in May 1985. The unusually malignant form of the disease was attributed to a combination of the virulence of this particular virus strain and to an extremely susceptible host population, due to a high population density of about 35 individuals per km² (Shimshony et al., 1986). Antibodies to bluetongue occur in wild *G. g. gazella*, but the virus causes no symptoms of the disease (Barzilai and Tadmor, 1972).

The estimated number of *G. g. gazella* in Israel in 1985 was about 10,000, a significant increase from the estimated 500 in 1948. The largest concentrations live in the southern Golan Heights (ca. 5000) and Ramot Yissakhar (ca. 3000). These populations, with free access to the water and green food during the summer provided by modern agricultural practices, increase at an annual rate of 16% (Ayal and Baharav, 1985) to 25% (Mendelssohn and Yom-Tov, 1987). Smaller populations exist in the Upper Galilee, mainly on the eastern slopes of Naftali Mountains, the Judean Hills, the Western Negev and other places.

The isolated population of 50 individuals (in 1987) near Elat, southern Israel (of an undescribed subspecies), although having free access to water and a seemingly ample supply of high-quality food (*Acacia* trees and many bushes), has not increased in number since 1962 when the first annual count was conducted (Yom-Tov and Ilani, 1987). Poaching in the past, and now predation by wolves and caracals may hinder population growth. A population of about 500 individuals of this undescribed subspecies lived near Hatzeva in the northern Arava Valley until the 1950s, and was exterminated by military poaching from 1956 to 1963 (Mendelssohn, 1974).

BEHAVIOR. *G. gazella* are excellent runners and for several hundred meters reach a speed of 80 km/hr. When frightened they may jump to a height of 2.4 m, but normally they cross fences by crawling under them; a space of 200 mm between fence and ground is sufficient. The high leaps (stotting) were noted as especially characteristic of this species by Vesey-Fitzgerald (1952). When excited or when fleeing, the white rump hair is erected, enlarging the size of the white rump patch by almost twice and making it, together with the dark frame and the wagging black tail, a conspicuous intraspecific communication mark. The dark side stripe, contrasting with the white underside, may also serve visual communication because it emphasizes the white underside when the gazelles are standing and somewhat also when they rest in the normal ruminant position. A frightened gazelle crouches in a straight posture, head and neck stretched on the ground. In this posture no white is visible and the dark side and buttock stripe are close to the ground producing a perfect countershading effect when the white is not showing, thus the gazelle looks like a rock or a clod of earth (Mendelssohn and Yom-Tov, 1987).

On hot days, gazelles rest while lying in the shade of bushes or trees (if available), whereas on cold and windy days they lie in shallow depressions dug with their front feet; these depressions are made in places protected by rocks, or in the open if no such places are available. In rocky parts of Arabia, they commonly rest under overhanging sandstone formations (Gross, 1987).

The vision of the mountain gazelle is acute and seems to be the most important sense, used in identifying enemies as well as conspecifics from a distance. They can see a large moving object from a distance of 1 km or more. They quickly learn to discriminate between a tractor (normally not a threat), and a jeep (sometimes with hunters). Their hearing and scent senses are also excellent. The sense of smell apparently is used for detecting predators, but mainly for food selection and intraspecific communication (Mendelssohn and Yom-Tov, 1987).

Gazella gazella has few calls. A sneeze-like voice serves as a warning call. While producing this call the nose is drawn down and forward. Females produce a low snoring voice to call the fawn. In extreme danger, for example while being captured by a predator, gazelles produce a strong bleating call. The bleating distress call of a fawn attracts the dam and releases aggressive behavior (Mendelssohn and Yom-Tov, 1987).

Gazella gazella is gregarious, and exhibit various social units: (a) young male herds aged 0.5–2 years or more and numbering up to 40 individuals; (b) adult male herds, numbering up to 40 individuals; (c) female herds comprising up to 16 females of various ages and accompanied by their sons (up to 6-months old) and daughters; and (d) territorial males, aged 3 years or more. *G. g. cora*, too, is territorial (Gross, 1987). In the Golan Heights only 10% of the adult males (older than 3 years) hold territories at any one time (A. Lotan, pers. comm.).

In northern Israel and the Golan Heights, territories vary in size between 0.2–0.5 km² (Baharav, 1983; A. Lotan, pers. comm.). Female herds roam freely in and between the territories, and their home ranges vary between 0.2–2 km². Territories are marked by urinating and defecating in several spots along the perimeter of a territory; urination and defecation are performed in a ritualized sequence in the same spot, and urination always precedes defecation (Grau and Walther, 1976). In Dubai, face-glands and feces apparently are used in marking (Gross, 1987). Dung heaps in such marking stations may cover an area of 1 m or more in diameter. After they are deserted, a luxuriant nitrophilous vegetation develops around such marking stations (Danin and Yom-Tov, 1990). Marking is done also by rubbing the base of the horns against trees while perhaps secreting odorous material from frontal glands, but these glands do not swell during the mating season (Habibi, 1992*b*). Possibly the branches from which the bark has been rubbed off confer visual as well as olfactory communication.

Territorial males may have encounters along the perimeter of their territories. They first perform a stiff-legged ceremonial walk side by side along the borders, sometimes standing in an anti-parallel position while displaying their horns. Fighting is carried out by pushing each other while pressing the horns against those of the rival male. The rings on the horns ensure a strong hold. They try from time to time to butt the unprotected flanks of the opponent, but always meet his horns. A fight ends when one of the rival males retreats under the pressure of the other and runs away, followed by the winner (Grau and Walther, 1976). Forelegs are never used in fighting (Habibi, 1992*b*).

The same agonistic behaviors are used interspecifically. At a feeding station in the Thumameh Wildlife Enclosure, near Riyadh,

Saudi Arabia, *G. gazella* interacted with two other gazelle species (*G. subgutturosa* and *G. dorcas*) with horn threat and rush-charge intention movements, horn clashes, butts, and chases. *G. gazella* was generally able to dominate *G. subgutturosa* of the same age-sex class, but was frequently dominated by *G. dorcas*, despite the latter's smaller size (Habibi, 1989).

GENETICS. There are 24 metacentric pairs of chromosomes, 8 acrocentric pairs, the X is metacentric, and both Y chromosomes are small acrocentrics (Effron et al., 1976). *G. gazella*, like *G. dorcas*, *G. leptoceros*, *G. subgutturosa*, *G. spekei*, *G. granti*, *G. dama* and *Antilope cervicapra* (but unlike *G. thomsoni*) has a translocation of the X chromosome into one of the autosomes, and two Y chromosomes, thus males have one more chromosome than females (2n = 35 and 34, respectively). Hybrids with *G. dorcas* are possible only by mating male *G. dorcas* with female *G. gazella*. Male hybrids are sterile, and female hybrids are subfertile (Wahrman et al., 1973). Hybrids have been obtained between male *G. subgutturosa* and female *G. gazella*. Two *dorcas* × *gazella* hybrid males were microschistic and sterile: one female hybrid also was sterile.

REMARKS. *G. arabica* was shown to be distinct from *G. gazella* by Groves (1983); the type and only known specimen supposedly was from the Farasan Islands, Saudi Arabia, but at present only *G. gazella farasani* occurs there (Thouless and Al Bassri, 1991; Thouless et al., 1991). *G. bennetti* (Iran, Pakistan and India), *G. leptoceros* (Sahara) and *G. subgutturosa* (Arabia to Mongolia) may also belong in this group.

It seems likely that additional subspecies must be recognized; thus, *G. g. erlangeri* may be a distinct race, and new subspecies are being described from the southern Negev, Israel, and from northwestern Iran.

In the bible gazelles are symbols of beauty ("My lover . . . be like a gazelle on the rugged hills" [Song of Songs 2, 17] and swiftness ("Asahel was as fleet-footed as a wild gazelle" [Samuel II, 2, 18]. Its common name in Hebrew and Arabic is "Zvi" and "idmi", respectively.

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LITERATURE CITED

AYAL, Y., AND D. BAHARAV. 1985. Conservation and management plan for the mountain gazelle in Israel. Pp. 269–278, *in* Game Harvest Management (S. L. Brown and S. F. Robertson, eds.). C. K. Wildlife Research, Atlanta, Georgia, 374 pp.

BAHARAV, D. 1983. Reproductive strategies in female mountain and dorcas gazelles (*Gazella gazella gazella* and *Gazella dorcas*). Journal of Zoology (London), 200:445–453.

BARZILAI, E., AND A. TADMOR. 1972. Experimental infection of the mountain gazelle (*Gazella gazella*) with bluetongue virus. Refuah Veterinaria, 29:45–50.

BATE, D. M. A. 1940. The fossil antelopes of Palestine in Natufian (Mesolithic) times, with description of new species. Oecological Magazine, 77:418–443.

BROOKE, V. 1874. On a new species of gazelle living in the society's menagerie. Proceedings of the Zoological Society of London, 1874:141–142.

DANIN, A., AND Y. YOM-TOV. 1990. Ant nests as primary habitats of *Silybum marianum* (Compositae). Plant Systematics and Evolution, 169:209–217.

DAVIS, S. 1980. Late Pleistocene-Holocene gazelles of northern Israel. Israel Journal of Zoology, 29:135–140.

DUCOS, P. 1968. L'origine des animaux domestiques en Palestine. Memoire no. 6, Publications de l'Institut de Prehistoire, Universite de Bordeaux (Delmas, Bordeaux), 191 pp.

EFFRON, M., M. H. BOGART, A. T. KUMAMOTO, AND K. BENIRSCHKE. 1976. Chromosome studies in the mammalian subfamily *Antilopinae*. Genetica, 46:419–444.

FERGUSON, W. W. 1981. The systematic position of *Gazella dorcas* (Artiodactyla: Bovidae) in Israel and Sinai. Mammalia, 45:453–457.

FLAMAND, J. R. B., C. R. THOULESS, H. TATWANY, AND J. F. ASMODE. 1988. Status of the gazelles of the Farasan Islands, Saudi Arabia. Mammalia, 52:608–610.

FURLEY, C. W. 1986. Effect of chemical immobilisation on the heart rate and haemotological values in captive gazelles. Veterinary Record, 1986:178–180.

GARROD, A. H. 1877. Notes on the visceral anatomy and osteology of the ruminants, with a suggestion regarding a method of expressing the relations of species by means of formulae. Proceedings of the Zoological Society of London, 1877:2–18.

GRAU, G. A., AND F. R. WALTHER. 1976. Mountain gazelle agonistic behaviour. Animal Behaviour, 24:626–636.

GROSS, C. 1987. Mammals of the southern Gulf. Motivate Publishing, Dubai, 79 pp.

GROVES, C. P. 1969. On the smaller gazelles of the genus *Gazella* de Blainville, 1816. Zeitschrift fur Saugetierkunde, 34:38–60.

———. 1983. Notes on the gazelles. IV. The Arabian gazelles collected by Hemprich & Ehrenberg. Zeitschrift fur Saugetierkunde, 48:321–329.

———. 1985. An introduction to the gazelles. Chinkara, 1:4–10.

GROVES, C. P., AND D. L. HARRISON. 1967. The taxonomy of the gazelles (genus *Gazella*) of Arabia. Journal of Zoology (London), 152:381–387.

GROVES, C. P., AND D. M. LAY. 1985. A new species of the genus *Gazella* (Mammalia: Artiodactyla: Bovidae) from the Arabian Peninsula. Mammalia, 49:27–36.

HABIBI, K. 1989. Dominance relationship among the gazelle species on feeding sites in captivity. Fauna of Saudi Arabia, 1:449–454.

———. 1992*a*. Reproductive strategy of the Farasan gazelle *Gazella gazella farasana*. Journal of Arid Environments, 23: 351–353.

———. 1992*b*. Arabian gazelles. National Commission for Wildlife Conservation and Development. Publication No. 4, Riyadh, 131 pp.

HARRISON, D. L. 1968. Mammals of Arabia, Vol. 2. Ernest Benn, London, 381 pp.

HARRISON, D. L., AND P. J. J. BATES. 1991. The mammals of Arabia. Harrison Zoological Museum, Sevenoaks, England, 354 pp.

MEINERTZHAGEN, R. 1954. Birds of Arabia. Oliver and Boyd, London, 624 pp.

MENDELSSOHN, H. 1974. The development of the population of gazelles in Israel and their behavioral adaptations. Pp. 122–143, *in* International Symposium on the behavior of ungulates and its relation to management, IUCN, Morges, Switzerland.

MENDELSSOHN, H., AND Y. YOM-TOV. 1987. The mammals of Israel. Pp. 1–295, *in* Plants and animals of the land of Israel: An illustrated encyclopedia. Vol. 7, (A. Alon, ed.) Ministry of Defence Publishing House and Society for the Protection of Nature, Tel Aviv, Israel. (in Hebrew)

MORRISON-SCOTT, T. C. S. 1939. Some Arabian mammals collected by Mr. H. St. J. B. Philby. C. I. E. Novitates Zoologicae, 41:181–211.

NADER, I. A. 1989. Rare and endangered mammals of Saudi Arabia. Pp. 220–233, *in* Wildlife conservation and development in Saudi Arabia (A. H. Abu-Zinada, P. D. Goriup, and I. A. Nader, eds.). National Commission for Wildlife Conservation and Development, Publication No. 3, Riyadh, 406 pp.

NEUMAN, M., AND T. A. NOBEL. 1978. Oesophageal worm (*Gongylonema pulchrum* Molin 1857) in a mountain gazelle (*Gazella gazella*). Acta Zoologica et Pathologica Antwerpiena, 70:149–151.

NOBEL, T. A., U. KLOPFER, AND M. NEUMAN. 1969. Toxoplasmosis in wild animals in Israel. Journal of Comparative Pathology, 79:127–129.

———. 1972. *Fasciliasis gigantica* in a nature reserve in Israel. Refuah Veterinarit, 29:33–34.

PALLAS, P. S. 1766. Miscellanea Zoologica. Hague comitun, 224 pp.

SAMBRAUS, H. H. 1973. Das Sexualverhalten der domestizierten einheimischen Wiederkäner. Fortschrift der Verhaltensforschung. H. 12. Verlag Paul Parey, Berlin, 100 pp.

SANBORN, C. C., AND H. HOOGSTRAAL. 1953. Some mammals of Yemen and their ectoparasites. Fieldiana Zoology, 34:229–252.

SHALMON, B. 1988. The Arava gazelle. Israel Land and Nature, 13:15–18.

SHIMSHONY, A., U. ORGAD, D. BAHARAV, S. PRUDOVSKY, B. YAKOBSON, B. BAR-MOSHE, AND D. DAGAN. 1986. Malignant foot-and-mouth disease in mountain gazelle. Veterinary Record, 19: 175–176.

SMITH, C. H. 1827. Order VII—Ruminantia (Pecora, Lin.), *in* The Animal Kingdom, arranged in conformity with its orga-

nization, by the Baron Cuvier, with additional descriptions of all the species hitherto named, and of many not before noticed. Vol. 4 (E. Griffith, ed.). Geo. B. Whittaker, London, 428 pp.

TCHERNOV, E., T. DAYAN, AND Y. YOM-TOV. 1986/7. The biogeography of *Gazella gazella* and *Gazella dorcas* in the Holocene of Israel. Israel Journal of Zoology, 34:51–59.

THOMAS, O. 1904. On a new gazelle from Palestine. Proceedings of the Zoological Society of London, 1904:347–349.

THOULESS, C. R., AND K. AL BASSRI. 1991. The taxanomic status of the Farasan Island gazelle. Journal of Zoology (London), 223:151–159.

THOULESS, C. R., J. G. GRAINGER, M. SHOBRAK, AND K. HABIBI. 1991. Conservation status of gazelles in Saudi Arabia. Biological Conservation, 58:85–98.

UERPMANN, H-P. 1986. Remarks on the prehistoric distribution of gazelles in the Middle East and Northeast Africa. Chinkara, 2:2–11.

VESEY-FITZGERALD, D. F. 1952. Wildlife in Arabia. Oryx, 1:232–235.

WAHRMAN, J., C. RICHLER, R. GOITIEN, A. HOROWITZ, AND H. MENDELSSOHN. 1973. Multiple sex chromosome evolution, hybridization and differential X chromosome inactivation in gazelles. Chromosomes Today, 42:434–435.

WALTHER, F. R. 1958. Zum Kampf und Paarangsverhalten einiger Antilopen. Zeitschrift fur Tierpsychologie, 15:340–380.

YOM-TOV, Y., AND G. ILANI. 1987. The numerical status of *Gazella dorcas* and *Gazella gazella* in the southern Negev Desert, Israel. Biological Conservation, 40:245–253.

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